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NORTH CAROLINA AIR QUALITY MAINTENANCE AREA ANALYSIS

VOLUME II. TSP POINT SOURCE EMISSION INVENTORIES, TSP MONITORING DATA AND METEOROLOGICAL DATA FOR CHARLOTTE, WINSTON-SALEM, AND GREENSBORO AQMA'S FOR 1973, 1975, 1980, AND 1985

North Carolina Department of Natural and Economic Resources

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APRIL 1976

FINAL REPORT

VOLUME II

TSP POINT SOURCE EMISSION INVENTORIES
TSP MONITORING DATA AND METEOROLOGICAL DATA FOR
CHARLOTTE, WINSTON-SALEM, AND GREENSBORO
AQMA'S FOR 1973, 1975, 1980, AND 1985

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV

AIR AND HAZARDOUS MATERIAL DIVISION
ATLANTA, GEORGIA 30309

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FINAL REPORT

Prepared By

Air Quality Section
Division of Environmental Management
Department of Natural and Economic Resources
State of North Carolina

Raleigh, North Carolina
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ABSTRACT

This report summarizes the procedures and results of the following activities of the North Carolina Air Quality Maintenance Area analysis which provided input data to the dispersion modeling phase of the analysis program: (1) the analyses of the 1973 baseline year point source emission inventories and the projection of point source emission inventories to 1975, 1980, and 1985; (2) the compilation of appropriate meteorological and climatological data for 1973, 1975, 1980, and 1985; (3) the validation of ambient monitoring data for 1973, and (4) the determination of those ambient monitoring sites which may be best represented by dispersion modeling. The methodologies incorporated were in accordance with those suggested by the Environmental Protection Agency (EPA). In some phases of the analysis, the North Carolina Air Quality Section used methods of projecting, systematic modifying and analyzing, and step validating which were not found in EPA literature. Whenever new approaches were used, the rationale for their preference has been explained.

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1. INTRODUCTION

1.1 OVERVIEW

The Air Quality Section, Division of Environmental Management, Department of Natural and Economic Resources (NCAQS), at the request of the Environmental Protection Agency (EPA), has conducted preliminary analyses of North Carolina's Air Quality Maintenance Areas (AQMAs). The NCAQS, with the concurrence of the EPA, has identified the following three areas as having the potential for violating the National Ambient Air Quality Standards (NAAQS) for total suspended particulate matter (TSP) within ten years: the Charlotte AQMA (Mecklenburg County), the Greensboro AQMA (Guilford County), and the Winston-Salem AQMA (Forsyth County). A detailed ten year projection analysis of air quality for each of the designated AQMAs has been prepared.

In a broad sense, the analysis of North Carolina's AQMAs has been performed in three overlapping, but distinctive, phases. Engineering-Science, Inc. (ES), McLean, Virginia, under contract to the EPA to assist the NCAQS is responsible for the analysis of area sources. This entails updating and allocating the baseline year area source emission inventories and projecting and allocating area source emission inventories for the future years of interest. Engineering-Science's work is reported in North Carolina Air Quality Maintenance Area Analysis, Volume I: TSP Area Source Emission Inventories for Charlotte, Winston-Salem, and Greensboro AQMAs for 1973, 1975, 1980, and 1985 (Ref: 1). Research Triangle Institute (RTI), Research Triangle Park, North Carolina, also under contract to the EPA to assist the NCAQS, is responsible for modeling, using appropriate diffusion model(s), the ambient

air quality for TSP for the baseline year and the future years of interest in each of the AQMAs. Research Triangle Institute's work is reported in North Carolina Air Quality Maintenance Area Analysis, Volume III: TSP Dispersion Modeling and Analysis for Charlotte, Winston-Salem, and Greensboro AQMAs for 1973, 1975, 1980, and 1985 (Ref: 2). The NCAQS, in addition to participation in the area source emission inventory phase and the modeling phase, had the sole responsibility for: the analysis of the baseline year and projected point source emission inventories; the compilation of appropriate meteorological and climatological input parameters; the validation and systematic modification of ambient monitoring data; and the analysis and rejection determinations of ambient monitoring sites.

This report summarizes the procedures and results of those activity areas of the analysis program for which the NCAQS had no contractural assistance. Discussed herein are pertinent characteristics of point source, meteorological, ambient monitoring, and monitoring site input parameters for all years modeled. The methodologies and procedures suggested in the EPA Guidelines for Air Quality Maintenance Planning and Analysis (Ref: 3) have been followed whenever possible, and the rationale for variations from said guideline procedures are explained. In some analysis situations, the NCAQS has methods of projecting, systematic analyzing and modifying, and step validating and rejecting which are not found in EPA documents or publications. Whenever new approaches are used, the rationale for their preference is discussed.

In early project coordination meetings between the EPA and the NCAQS, the projection of TSP ambient air quality concentrations for the years of 1975, 1980, and 1985 were agreed upon. These years remain the projection years for the entire analysis. In an effort to properly project ambient air quality concentrations through the use of available modeling techniques, the necessity of developing a "calibration," the relationship between calculated air quality

and observed air quality, led to the selection of 1973 as the baseline year. The year 1973 was chosen because it was the most current year for which emissions data (from both point sources and area sources), meteorological data and TSP monitoring data were available for the three study areas. Also agreed upon was the use of the Air Quality Display Model (AQDM)(Ref: 4) in the analysis to represent predicted TSP ambient air quality concentrations. It was felt that the AQDM was representative of the best available technique for dispersion modeling.

The analysis described herein has resulted in the following input for the modeling analysis:

1. point source emission inventories for the baseline calibration year of 1973 and for the projection years of 1975, 1980, and 1985 (including point source emissions projected solely from anticipated economic growth);
2. meteorological parameters specifically representative of 1973 and climatological data for the projection years of 1975, 1980, and 1985;
3. refined 1973 air quality monitoring data; and
4. identification of the monitoring stations most representative of non-biased sampling with regard to local influences which cannot be defined by AQDM.

Throughout various phases of the analysis, conferences for the purpose of technical coordination were held with representatives from EPA, ES, RTI, the local air pollution control agencies, the local planning agencies, and the NCAQS. Such meetings allowed for schedule coordination, resolution of disparities or discrepancies, discussions of the necessity and the rationale of procedural modifications, and joint agreements concerning new approaches to technical problems.

1.2 LOCAL AIR POLLUTION CONTROL AGENCY PARTICIPATION

Two of the three AQMAs in North Carolina, the Charlotte AQMA and the Winston-Salem AQMA, are under the direct jurisdiction of fully approved local air pollution control agencies, viz. the Mecklenburg County Department of Public Health and the Forsyth County Environmental Affairs Department. From the beginning of the coordination of the project, both local agencies have expressed an active interest and willingness to participate and have assisted in various aspects of the analysis. These local agencies are best suited for collecting necessary point source inventory data, insofar as each agency not only has an excellent knowledge of, but also maintains a cooperative working relationship with, the point sources within its jurisdiction.

Frequently, the local agencies have been able to give insight or direction to subjects which might have been peculiar to their individual county, such as area source emissions related to local ordinances or the evaluation of data from particular monitoring stations in order to eliminate objectionable biases. Both agencies have viewed assistance in the analysis as serving a complementary purpose. The necessary updating and projecting of the emission inventories not only serves the NCAQS analysis but also serves their own agency in continual source registration and program planning activities. Likewise, monitoring data validation and detailed monitoring site evaluations have been determined to be mutually beneficial.

2. POINT SOURCE EMISSION INVENTORY

2.1 POINT SOURCE DEFINITION

A point source is defined by the Federal Register, Volume 38, Number 149 of August 3, 1973, as any one site having 100 tons per year or greater of uncontrolled emissions for any one pollutant, and those sources having less than 100 tons per year of uncontrolled emissions for any one pollutant are defined as area sources. However, there are a few categories of stationary sources which, due to the specific nature of their operation, are defined as point sources regardless of their uncontrolled emission rates.

For the purpose of North Carolina's preliminary AQMA analysis, the decision has been made that the comprehensiveness of this definition is not compatible with the overall scope of the project. With consideration towards obtaining the best possible resolution, a point source is redefined as any source having five tons per year or greater of actual particulate emissions. Any source having less than five tons per year of particulate emissions is considered an area source. During preliminary investigations, it has been determined that many sources which are located in the proximity of monitoring stations might be influencing the particulate samples measured at these stations. Since emission data on such sources are readily available, a higher degree of resolution is feasible. This reasoning leads to the final definition of a point source used in the AQMA analysis as all stationary sources having particulate emissions of one ton per year or greater within three kilometers of any sampling station and all stationary sources having particulate emissions of five tons per year or greater in the remainder of the designated AQMA.

2.2 PROCEDURE OF UPDATING AND PROJECTING EXISTING INVENTORY

The amended definition has been adherred to in the analysis of all AQMAs but, because of the variance of the ambient air monitoring networks between the individual counties, the extensiveness of the sources surveyed to some degree differs. In the counties of Mecklenburg and Forsyth, the three kilometer radius geographically covers an area encompassing virtually all point sources of one ton per year or greater. On the other hand, as the monitoring network in Guilford County has been concentrated primarily in the metropolitan areas, many sources of less than five tons per year of emissions lying outside of the metropolitan areas have not been identified as point sources. This should not be construed as being less accurate since, in the derivation of the definition of a point source, smaller sources further than three kilometers from the sampling stations have been determined through modeling to be insignificant as individual point sources. The parameters to be used as input for these point sources in the model have been found to be unnecessary to estimate their effects on air quality,and such sources can properly be treated as area sources.

Although the geographical boundaries of the three AQMAs have been defined as the political boundaries of the counties, point sources in adjoining counties which show a potential for significantly affecting the air quality with respect to particulate concentrations within an AQMA have been included in the emissions inventory. Such determinations have been made through the use of individual point source modeling.

Personal interviews have been conducted with knowledgeable personnel representing all point sources, as recommended by "Level 3" analysis (Ref: 5), which is the most accurate method of updating and projecting point source emissions. To assist in the point source interviews, an "Emission Inventory Survey" form (Figure I) has been developed. Questions have been designed to be direct

FIGURE I

EMISSION INVENTORY SURVEY

1. Company Name: _____

2. Location: Long. _____ Lat. _____

   UTMH _____ UTMV _____ Map No. _____

3. Type Facility: _____

4. a. 1973 Annual Production Rate or Fuel Usage and Type:

   P. R. _____ F. U. _____ Type _____

   b. Maximum Hourly Rate

   P. R. _____ F. U. _____

   % Ash for Coal: _____

5. 1973 Actual Emission Rate: _____ tons

6. Days of Operation: _____

7. Estimated Production Rate or Fuel Usage by Type (May be given as a number or % increase or decrease):

	P. R.	F. U.	Type
1975			
1980			
1985			

8. At what Capacity was the Plant Operating in 1973: _____

9. If No Addition or Deletions at What Capacity will It be Operating in:

   1975 _____ 1980 _____ 1985 _____

10. Are There to be Any Additions or Deletions to Plant by:

    1975 _____ 1980 _____ 1985 _____

11. With Addition or deletion at what capacity will Plant Operate in:

    1975 _____ 1980 _____ 1985 _____

12. a. Are There to be Any New Boilers (for combustion Sources)

    by: 1975 _____ 1980 _____ 1985 _____

b. What Will be the Fuel Usage in 1975 _____

1980 _____ 1985 _____ Type of Fuel _____

c. What will be Capacities of the New Boilers:

13. Will There be Any New Stacks by 1975, 1980, 1985 for process or Boiler: _____ If Known Supply following Stack Information.

STK HT _____ ft. EXIT VEL _____FPM or _____ CFM

STK DIA _____ ft. STK TEMP _____ ^{o}F

14. a. Is There to be Any Control Equipment Added After 1973: ____

On What: _____

Type of Control Equipment _____

% Eff. _____ Installation Date _____

b. Type of Existing Control Equipment: _____

% Eff. _____ On What _____

STACK PARAMETERS

STK HT _____ ft. Exit VEL _____FPM or _____CF

STK DIA _____ ft. STK TEMP _____ ^{o}F

CALCULATED DATA

EMISSIONS Tons/day

1973 1975 1980 1985

STACK PARAMETERS

STK HT _____ m EXIT VEL _____ m/sec.

STK DIA _____ m^2 STK TEMP _____ ^{o}K

FIGURE I (cont.)

Company Name _____

REMARKS

(Include Assumptions Made in Calculating or Estimating Emissions, Stack Parameters, Etc.)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Emission Factor _____

NOTE: For new sources an hourly production rate is also needed so that allowable emissions can be calculated (this will be the actual emission rate unless it is known otherwise).

NOTE: If there are more than one source within the plant which cannot or should not be combined, then these data are needed for each source.

and to be answered in short statements. Assumptions and pertinent calculations have been recorded under the section of the survey form entitled "Remarks." Emission factors have been obtained from the EPA document Compilation of Air Pollutant Emission Factors (AP-42) (Ref: 6) and have been recorded under the section entitled "Emission Factors."

The completed survey has resulted in a total of 260 forms. Each source interviewed has been informed how the furnished information is to be used and has been assured of the Department's discretion with confidential information. The sources have been very cooperative in providing the most specific information available for the base year (1973) and their most realistic projection of parameters for future years.

To provide a method of cross-referencing between survey forms and source locations, each survey form has been assigned an identification number (Map No.). The sources have then been located by Universal Transverse Mercator (UTM) coordinates and the identification numbers denoted on appropriate United States Geodetic Survey (USGS) maps. This cross-referencing technique serves a dual purpose. It has not only been used to relate specific sources to their geographical location, but also provides a source identification number for the entire analysis.

In an effort to totally identify the point sources within the scope of the definition, various sources of information have been solicited. Included in their order of priority are detailed searches of NEDS, air quality files, and industrial listing references and consultations with appropriate local environmental agencies. A complete list of point sources has been compiled, and interviews have been conducted. In addition to emission parameters, the name of the interviewer and responsible individual with the source and the date of the interview have been recorded on each survey form. If any questions arise over any portion of the information contained on a survey form, this allows for appropriate contacts to be made.

With reference to projected operation and emission rates, general county growth rates have been used for the sources for which projections of future process rates or fuel usage are unavailable. The growth rates used for the industrial source category and the commercial and institutional source category where better information is unavailable are the same as those used for area sources in the respective counties.

2.3 PROJECTING GROWTH FROM UNKNOWN POINT SOURCES

2.3.1 GENERAL

In addressing future air quality, a total emission inventory must include the emissions from future unknown sources in addition to the projected emissions from existing known sources. Even though the emissions resulting from projected growth of unknown sources was found to be relatively small in magnitude when compared to the total emissions inventory, the category of sources should be considered because their impact on the air quality of local areas could be significant. In order to achieve the best level of analysis, projection information for manufacturing employment was obtained from local city and county planning agencies. Equations were then formulated to relate employment growth parameters and to project future emissions for each AQMA.

2.3.2 LEVEL OF ANALYSIS

Manufacturing employment has been used instead of OBERS [1] earnings for several reasons. First, OBERS projections are available for only entire Standard Metropolitan Statistical Areas (SMSA) and not for the individual counties comprising the SMSAs, and as the counties considered in this study are only portions of large SMSAs, it was felt that proportioning OBERS earnings among counties within a SMSA might produce unrepresentative results. Also,

[1] OBERS: Economic measurement, analysis and projection conducted by The Bureau of Economic Analysis, U. S. Department of Commerce, and the Economic Research Service, U. S. Department of Agriculture.

manufacturing employment projection estimates have been made by and were available from city and county planning agencies. Such projections are believed to be more reliable than those available from OBERS, since the local planning agencies should have a better understanding of the growth patterns within their individual areas. Therefore, "Level 2" has been used instead of "Level 1" (Ref: 5) to project emissions from new unknown industrial point sources. "Level 3" analysis, which is the most accurate, cannot be used in this case since it requires interviews with each individual source, and by definition, none of the new unknown industrial point sources exist at the time that projections are determined.

2.3.3 PROJECTION OF EMISSIONS FROM FUEL COMBUSTION SOURCES

In projecting emissions from the new unknown industrial point source fuel usage category, the assumption that BTU usage for all industrial point sources increases at the same rate as total manufacturing employment has been made. The total number of BTUs consumed by industrial point sources in the base year (1973) has been determined. The projected BTU consumption has been derived by multiplying the base year BTU consumption by the ratio of the total number of manufacturing employees during each projected year (1975, 1980, or 1985) to the total number of manufacturing employees during the base year. This product has been distributed by the five basic types of fuels (distillate oil, residual oil, coal, natural gas, and wood), assuming that the distribution of fuel consumption by the new unknown sources in the projection years is proportional to the distribution of fuel consumption by the existing sources in the projection year. Subtracted from these total quantities of fuels are the known quantities of fuels which have been estimated to be used by existing industrial point sources for each projection year. Each calculated difference

becomes the quantity of that type of fuel which is projected to be used by new unknown point sources. In mathematical form:

$$T_{ij} = \frac{P_{ij}(M_j)\sum_{i=1}^{5}[(F_i)(A_i)]}{E(F_i)} - R_{ij}$$

Where:

T = Total estimated quantity of fuel used by new unknown industrial point sources in tons, cubic feet, or gallons.

P = Fraction of the total BTUs generated by industrial point sources by fuel type for 1975, 1980, and 1985, respectively.

M = Total projected manufacturing employment.

F = Heat content in BTUs for each type of fuel.

A = Quantity of each type of fuel used by industrial point sources in the base year (1973).

E = Total manufacturing employment for 1973.

R = Total quantity of fuel used by known point sources in tons, cubic feet, or gallons.

Subscript i = Type of fuel (coal, distillate oil, residual oil, natural gas, or wood).

Subscript j = Year (1975, 1980, or 1985).

These values have been calculated for Mecklenburg, Guilford and Forsyth Counties and the results are in Tables I, II, and III. (A negative difference indicates that the existing sources are increasing at a greater rate than the projected employment. Therefore, it is assumed that all new fuel usage is accounted for by the projected expansion of existing sources.)

TABLE I

PROJECTED FUEL USAGE BY NEW UNKNOWN FUEL COMBUSTION SOURCES IN MECKLENBURG COUNTY

$$T_{ij} = \frac{P_{ij}(M_j)\sum_{i=1}^{5}[(F_i)(A_i)]}{E(F_i)} - R_{ij}$$

	M
1975	48,750
1980	52,000
1985	62,000

E = 48,208

Fuel Type	P			R			A	F	T		
	1975	1980	1985	1975	1980	1985	1973		1975	1980	1985
Dist. Oil	.0667	.0931	.1004	1673	2578	2996	1346	140	15	-64	236
Coal	.0016	.0022	.0996	219	328	16000	219	26	0	-8	1263
Nat. Gas	.2058	.0598	.0627	723	232	262	1614	1000	6	-6	21
Res. Oil	.7258	.8449	.7373	16996	21844	20529	11306	150	149	-554	1622
Wood	.0000	.0000	.0000	0	0	0	0	16	0	0	0

T = The total estimated quantity of distillate oil in 1000 gallons, coal in tons, natural gas in million cubic feet, residual oil in 1000 gallons, and wood in tons.

P = The fraction of total BTU generated by industrial point sources by fuel type and for 1975, 1980 and 1985, respectively.

M = Total manufacturing employment.

F = Heat content in million BTU.

A = Quantity of each type of fuel used by industrial point sources in 1973.

E = Total manufacturing employment in 1973.

R = The total quantity of fuel used by known point sources.

Subscript i = Type of fuel (coal, distillate oil, residual oil, natural gas, or wood).

Subscript j = Year (1975, 1980, or 1985).

TABLE II

PROJECTED FUEL USAGE BY NEW UNKNOWN FUEL COMBUSTION SOURCES IN GUILFORD COUNTY

$$T_{ij} = \frac{P_{ij}(M_j)\sum_{i=1}^{5}[(F_i)(A_i)]}{E(F_i)} - R_{ij}$$

	M
1975	100,990
1980	114,828
1985	129,466

E = 62,950

Fuel Type	P			R			A	F	T		
	1975	1980	1985	1975	1980	1985	1973		1975	1980	1985
Dist. Oil	.0580	.0590	.0629	2,030	2,140	2,250	9,860	140	1,225	1,625	2,275
Coal	.0364	.0387	.0394	6,850	7,550	7,600	28,550	26	4,149	5,747	7,663
Nat. Gas	.1511	.1577	.1727	740	800	865	905	1,000	447	609	874
Res. Oil	.6228	.6010	.5661	20,330	20,330	18,905	8,020	150	12,291	15,462	19,107
Wood	.1316	.1436	.1589	40,270	45,550	49,750	41,660	16	24,351	30,425	58,367

T = The total estimated quantity of distillate oil in 1000 gallons, coal in tons, natural gas in million cubic feet, residual oil in 1000 gallons, and wood in tons.

P = The fraction of total BTU generated by industrial point sources by fuel type and for 1975, 1980, and 1985, respectively.

M = Total manufacturing employment.

F = Heat content in million BTU.

A = Quantity of each type of fuel used by industrial point sources in 1973.

E = Total manufacturing employment in 1973.

R = The total quantity of fuel used by known point sources.

Subscript i = Type of fuel (coal, distillate oil, residual oil, natural gas, or wood).

Subscript j = Year (1975, 1980, or 1985).

TABLE III

PROJECTED FUEL USAGE BY NEW UNKNOWN FUEL COMBUSTION SOURCES IN FORSYTH COUNTY

$$T_{ij} = \frac{P_{ij}(M_j)\sum_{i=1}^{5}[(F_i)(A_i)]}{E(F_i)} - R_{ij}$$

	M
1975	39,430
1980	39,400
1985	41,370

E = 39,440

Fuel Type	P			R			A	F	T		
	1975	1980	1985	1975	1980	1985	1973		1975	1980	1985
Dist Oil	.0164	.0161	.0162	476	480	487	473	140	-49	-61	-44
Coal	.4672	.4894	.5009	72,850	78,659	80,993	68,210	26	-7,323	-10,071	-7,283
Nat. Gas	.1302	.1261	.1249	528	527	525	1,050	1,000	-53	-68	-47
Res. Oil	.3551	.3384	.3280	9,597	9,428	9,193	4,216	150	-964	-1,208	-827
Wood	.0310	.0301	.0300	7,847	7,854	7,874	7,840	16	-782	-999	-700

T = The total estimated quantity of distillate oil in 1000 gallons, coal in tons, natural gas in million cubic feet, residual oil in 1000 gallons, and wood in tons.

P = The fraction of total BTU generated by industrial point sources by fuel type and for 1975, 1980, and 1985, respectively.

M = Total manufacturing employment.

F = Heat content in million BTU.

A = Quantity of each type of fuel used by industrial point sources in 1973.

E = Total manufacturing employment in 1973.

R = The total quantity of fuel used by known point sources.

Subscript i = Type of fuel (coal, distillate oil, residual oil, natural gas, or wood).

Subscript j = Year (1975, 1980, or 1985).

By multiplying each quantity of fuel by its appropriate emission factor, the amount of emissions projected from new unknown point source fuel usage is calculated. These values are compiled in Tables IV and V for Mecklenburg and Guilford Counties. (A zero in the table denotes that the computed particulate emission is less than 0.5 tons per year or that there is no projected fuel comsumption by new unknown sources.) For Forsyth County, no emissions have been projected from new unknown fuel combustion sources since all the projected increases in fuel usage are being accounted for by the expansion of existing sources.

TABLE IV

PROJECTED PARTICULATE EMISSIONS FROM NEW UNKNOWN FUEL COMBUSTION SOURCES

IN

MECKLENBURG COUNTY

Fuel	Emission Factors	Emissions (Tons/Year) 1975	1980	1985
Dist. Oil	15 lbs./1000 gal.	0	0	2
Coal	18.2 lbs./ton*	0	0	11
Nat. Gas	10 lbs./million cu. ft.	0	0	0
Res. Oil	23 lbs./1000 gal.	2	0	19
Wood	5 lbs./ton	0	0	0

*Emission Factor for Coal is 13A; for an Ash Content of 7% and assuming a Control Efficiency of 80%, the Emission Factor becomes 18.2 lbs./ton.

TABLE V

PROJECTED PARTICULATE EMISSIONS FROM NEW UNKNOWN FUEL COMBUSTION SOURCES

IN

GUILFORD COUNTY

Fuel	Emission Factor	Emissions (Tons/Year) 1975	1980	1985
Dist. Oil	15 lbs./1000 gal.	9	12	17
Coal	18.2 lbs./ton*	38	52	70
Nat. Gas	10 lbs./million cu. ft.	2	3	4
Res. Oil	23 lbs./1000 gal.	141	178	220
Wood	5 lbs./ton	61	76	146

*Emission Factor for Coal is 13A; for an Ash Content of 7% and assuming a Control Efficiency of 80%, the Emission Factor becomes 18.2 lbs./ton.

The projection method of emissions from new unknown fuel combustion point sources is a modified version of the "Level 2" method described in Reference 5. The primary difference is that in this analysis the BTU equivalent for point sources and area sources have not been aggregated, but each has been projected independently.

2.3.4 PROJECTION OF EMISSIONS FROM INDUSTRIAL PROCESS SOURCES

Industrial process emissions are projected by assuming that the emissions increase at the same rate as the manufacturing employment within the particular Standard Industrial Classification (SIC) group to which the process belongs. For the base year (1973) the emissions of each individual point source, for the purpose of projecting, are determined by assuming that the particular emissions from the source are controlled to the degree necessary to achieve compliance with all applicable standards. The emissions from each source in a SIC group are first summed and then multiplied by the ratio of the total number of employees in the particular SIC group during each projection year to the number of employees in that SIC group during the base year (1973). The total known emissions for each projection year, assuming sufficient particulate emission control to effect compliance, are subtracted from this product. The difference, is attributed to new unknown point source industrial processes in the particular SIC group. (A negative number indicates that the existing sources are increasing at a greater rate than the projected employment; whereby, it is assumed that all process emissions are accounted for by the expansion of existing sources.) In mathematical form:

$$G_{ij} = \frac{(A_i)(E_{ij})}{B_i} - D_{ij}$$

Where:

G = The estimated tons per year of particulate emissions from new unknown point source industrial processes.

A = Base year (1973) particulate emissions in tons per year assuming actual or allowable emissions, whichever is less.

B = 1973 manufacturing employment.

E = Projected manufacturing employment.

D = Total known tons per year of emissions from industrial processes assuming actual or allowable emissions in tons per year, whichever is less.

Subscript i = SIC Group (20, 21, 22, 24, 25, 26, 28, 32, or 33).

Subscript j = Year (1975, 1980, or 1985).

This method is used for each SIC group that may contain sources which are significant emitters of particulates in the study areas, i.e. SIC groups:

20 (food and kindred products)
21 (tobacco manufacturers)
22 (textile mill products)
24 (lumber and wood products)
25 (furniture and fixtures)
26 (paper and allied products)
28 (chemical and allied products)
32 (stone, clay, and glass products)
33 (primary metal industries)

The aforementioned technique has been used to project new unknown point source industrial process emissions in Guilford and Mecklenburg Counties, since the local planning agencies in these two counties have been able to provide employment data by SIC groups. However, the Forsyth County planning agency has been unable to provide employment data by SIC groups. In order to project point source industrial process emissions in Forsyth County, the ratio of the total manufacturing employment in each projection year to the total manufacturing employment in the base year (1973) is used.

The primary difference between the method that has been used to project emissions from new unknown industrial process point sources in Guilford, Forsyth, and Mecklenburg Counties and the "Level 2" method, as described in Reference 5, is that "Level 2" projects rates of throughput, whereas the method used in this analysis projects emission rates. Emission rates are used instead of throughput because they give essentially the same results but eliminate several intermediate calculation steps.

The emission projections from new unknown point source industrial processes in Mecklenburg, Guilford, and Forsyth Counties are presented in Tables VI, VII, and VIII.

TABLE VI

PROJECTED PARTICULATE EMISSIONS FROM NEW UNKNOWN INDUSTRIAL PROCESS SOURCES IN MECKLENBURG COUNTY

$$G_{ij} = \frac{(A_i)(E_{ij})}{B_i} - D_{ij}$$

SIC	A	B	E			D			G		
GROUP	1973	1973	1975	1980	1985	1975	1980	1985	1975	1980	1985
20	45	5990	5990	5990	5990	41	44	43	3	1	2
25	1	1161	1161	1161	1161	1	1	2	0	0	-1
28	6	6108	6111	6343	6628	4	8	9	2	-2	-3
32	1361	1425	1425	1425	1425	1362	1776	2217	-1	-351	-792
33	164	1113	1132	1207	1297	166	157	181	0	20	10

A = 1973 emissions assuming actual or allowable emissions, in tons per year, whichever is less.

B = Manufacturing employment in 1973.

E = Manufacturing employment.

D = Total known emissions, in tons per year, from industrial process, sources, assuming actual or allowable emissions, whichever is less.

G = Estimated tons of emissions per year from new unknown industrial process sources.

Subscript i = SIC Group (20, 25, 28, 32, or 33).

Subscript j = Year (1975, 1980, or 1985).

TABLE VII

PROJECTED PARTICULATE EMISSIONS FROM NEW UNKNOWN

INDUSTRIAL PROCESS SOURCES IN GUILFORD COUNTY

$$G_{ij} = \frac{(A_i)(E_{ij})}{B_i} - D_{ij}$$

SIC Group	A	B	E			D			G		
	1973	1973	1975	1980	1985	1975	1980	1985	1975	1980	1985
20	25	2646	2608	2088	1817	20	20	20	5	0	-3
22	14	19792	22447	27016	30284	13	16	13	3	3	2
24	306	1107	1277	1447	1734	297	307	311	56	93	168
25	244	11725	15599	17791	19967	215	242	240	110	128	176
28	46	2966	3289	4056	4715	70	70	70	-19	-7	3
32	1576	1046	1038	1107	1160	1639	1962	2417	-75	-294	-425
33	10	363	462	522	586	9	9	9	3	5	7

A = 1973 emissions assuming actual or allowable emissions, in tons per year, whichever is less.

B = Manufacturing employment in 1973.

E = Manufacturing employment.

D = Total known emissions, in tons per year, from industrial process sources assuming actual or allowable emissions, whichever is less.

G = Estimated emissions, in tons per year, from new unknown industrial sources.

Subscript i = SIC Group (20, 22, 24, 25, 28, 32, or 33).

Subscript j = Year (1975, 1980, or 1985).

TABLE VIII

PROJECTED PARTICULATE EMISSIONS FROM NEW UNKNOWN INDUSTRIAL PROCESS SOURCES IN FORSYTH COUNTY

$$G_i = \frac{(A_i)(E_i)}{B_i} - D_i$$

SIC GROUP	E	B	A	D	G
33	40,380	39,440	2	0	2
20	40,380	39,440	2	3	-1
21	40,380	39,440	143	143	3
32	40,380	39,440	226	476	-245
25	40,380	39,440	18	18	0
28	40,380	39,440	13	11	2
26	40,380	39,440	6	7	-1

E = 1985 manufacturing employment.

B = 1973 manufacturing employment.

A = 1973 emissions assuming actual or allowable emissions, in tons per year, whichever is less.

D = Total estimated emissions from known sources in tons per year in 1985.

G = Estimated tons of emissions per year from new unknown industrial sources in 1985.

Subscript i = SIC Group (20, 21, 25, 26, 28, 32, or 33).

2.3.5 PROJECTION OF EMISSIONS FROM COMMERCIAL-INSTITUTIONAL SOURCES AND INCINERATION SOURCES

No new unknown point source projections have been made for commercial and institutional sources or for incineration sources. All new sources in these categories are projected as area sources.

2.3.6 ALLOCATION OF NEW UNKNOWN POINT SOURCES

The total emissions as discussed in Section 2.3.3 and 2.3.4 are then divided into individual sources of average or typical size in each particular source category in order to allocate into potential grow areas.

Each local planning agency has provided zoning maps showing areas of potential new industrial growth for 1975, 1980, and 1985. The new unknown point sources are then allocated within these growth areas by specific UTM coordinates.

A source which has been projected to begin operating in 1975 is assigned to a corresponding 1975 potential growth area. Likewise, a source which begins operating in 1980 or 1985 is assigned to a 1980 or a 1985 potential growth area, respectively.

A new unknown point source which has been projected to begin operation in 1975 is assumed to remain in existence for 1980 and 1985 where projected emissions in 1980 and 1985 are such that the new growth is not accounted for by the growth of existing 1973 sources. In some instances this has accounted for part, if not all, of the projected emissions from new unknown point sources in these two later years. However, if there are no projected emissions in 1980 or 1985 for a point source which has been projected to begin operation in 1975, the source has been assumed to have ceased operating in 1980 or 1985, whenever appropriate. The same is true for new unknown point sources predicted to begin operation in 1980 with respect to 1985.

In Mecklenburg County, two probable industrial growth areas have been located by the Charlotte-Mecklenburg Planning Commission. One area is north of Charlotte, and the other is generally south. Both areas are approximately equal in size. The predicted new unknown point sources have been allocated between the two areas by total tons of emissions.

The emissions from fuel combustion for 1975 have been allocated to the area north of Charlotte. For 1985 the emissions have been totalled and divided in half, giving two sources of 16 tons per year each. One source is placed in the growth area north of Charlotte, and the other is placed in the growth area south of Charlotte.

Several new unknown industrial processes in SIC groups 20, 28, and 33 have been projected for Mecklenburg County. Since the average size source in SIC group 20 emits approximately six tons of particulate per year, only one new source is assumed for 1975, 1980, and 1985, respectively. These sources are assigned to the industrial growth area to the north of Charlotte. For SIC group 33, the average size source is on the order of five tons per year. Thus, four new sources of typical size are predicted for 1980 and two for 1985. The new sources in group 33 have been evenly distributed between the two industrial growth areas. As for SIC group 28, only one small source of two tons per year is projected for 1975, and it has been placed in the industrial growth area to the south of Charlotte.

In Forsyth County, three sources, a tobacco processing plant (SIC group 21), a chemical plant (SIC group 28), and a secondary metals plant (SIC group 33), have been located for the year 1985 with the assistance of the City-County Planning Board.

The group 21 source is located northwest of Winston-Salem, the group 28 source is located south of Winston-Salem, and the group 33 source is located in the eastern part of Winston-Salem.

Since there is essentially no predicted increase in manufacturing employment in 1975 or 1980 in Forsyth County, there are no emissions projected from new unknown industrial process point sources. As for new unknown fuel combustion point sources, none are predicted because the projected increase in fuel usage is being accounted for by the expansion of existing sources.

In Guilford County, a relatively large number of new unknown point sources have been projected and located. Whenever possible, a fuel combustion source and an industrial process source have been assigned the same location to decrease the number of arbitrary site selections. Since the furniture industry in the county is concentrated in and around the city of High Point, all projected emissions in SIC group 25 have been assigned to the designated areas of growth in that particular region. These areas have been identified by the City of High Point Department of Planning. The remaining industrial process sources have been allocated at various areas of industrial growth that have been designated by the City of Greensboro Department of Planning. The predicted new unknown fuel combustion point sources which have not been combined with appropriate process sources have been located in the growth areas around Greensboro. The number and the size of sources in tons of emissions per year are presented in Table IX.

TABLE IX

PROJECTED NEW UNKNOWN SOURCES IN GUILFORD COUNTY

	No. of Sources			Respective Emissions (tons/year/source)		
	1975	1980	1985	1975	1980	1985
Type of Source:						
Residual Oil	10	12	15	13	14	14
	1	1	1	11	10	10
Distillate Oil	4	6	7	2	2	2
	1		1	1		3
Natural Gas	1	1	2	2	3	2
Wood	9	14	20	6	5	7
	1	1	1	7	6	6
Coal	7	2	3	5	6	6
	1	1	1	3	4	10
		1	1		36	42
SIC Group:						
20	1			5		
22	1	1	1	3	3	2
24	1	2	4	37	38	39
	1	1	1	17	17	12
25	14	14	19	7	9	9
	1	1	1	12	2	5
28			1			3
33	1	1	1	3	5	7

2.3.7 STACK PARAMETERS FOR NEW UNKNOWN POINT SOURCES

The stack parameters are a necessary part of tne input to the AQDM in addition to the source location and quantity of emissions. Most of the stack parameters have been determined by using Exhaust Gases from Combustion and Industrial Processes (Ref: 8), giving typical stack parameters for different types of boilers and processes. However, since a few sources such as furniture manufacturing are not included in said reference, the stack parameters are assumed to be similar to those of existing sources of the same type.

2.4 POINT SOURCE EMISSION INVENTORY SUMMARY

The computational methodologies incorporated in the analyses of the point source emission inventories resulted in completion of necessary keypunch load sheets for input to the AQDM for the calibration year of 1973 and the projection years of 1975, 1980, and 1985. These results are presented in summary form in Table X.

TABLE X

POINT SOURCE EMISSION SUMMARY

(Tons Per Year)

	1973	1975	1980	1985
FORSYTH COUNTY				
Known in Place Growth	1,746.33	957.54	1,065.08	1,107.97
Knew Unknown Growth	----	0	0	7.00
Total Point Source	1,746.33	957.54	1,065.08	1,114.97
New Unknown Percent Total	----	0	0	0.6
GUILFORD COUNTY				
Known in Place Growth	3,088.08	3,897.11	3,569.16	3,725.95
New Unknown Growth	----	428.00	550.00	813.00
Total Point Source	3,088.08	4,325.11	4,119.16	4,538.95
New Unknown Percent Total	----	15.4	13.4	17.9
MECKLENBURG COUNTY				
Known in Place Growth	35,286.00	5,416.35	6,090.16	6,260.91
New Unknown Growth	----	7.00	21.00	44.00
Total Point Source	35,286.00	5,423.35	6,111.16	6,304.91
New Unknown Percent Total	----	0.1	0.3	0.7

3. CLIMATOLOGY AND METEOROLOGY

3.1 INTRODUCTION

The climatology and meteorology for the AQMAs are outlined in this section. Sources of climatological and meteorological data are supplied. The impartant climatological factors relating to pollution dispersal are addressed. Procedures used to refine the meteorological data for modeling are presented, and final meteorological computer inputs are listed in Table XI.

3.2 CLIMATOLOGY

3.2.1 GENERAL

The climatology of the three AQMAs is divided into two regions. The first region is comprised of Guilford and Forsyth Counties. Climatological information from the National Weather Service Field Office (NWSFO) located at Greensboro, North Carolina is used for this region. The NWSFO located at Charlotte, North Carolina is the source of climatological information for the remaining AQMA, Mecklenburg County. Various long term climatological features have been compared to the specific climatology of the calibration year 1973. Outlined in this section are climatological features which should be considered when conducting an analysis of the impact of emissions on ambient air quality. Because meteorological factors such as precipitation, wind, mixing height, and stability do not remain constant from year to year, understanding the norm for these factors is important when performing air quality analyses.

3.2.2 SOURCES OF CLIMATOLOGICAL DATA

The primary source of climatological data is the National Climatic Center (NCC), Asheville, North Carolina. The Center has supplied "Local Climatological

Data" (Ref: 9), and stability wind rose (Ref: 10) information for the appropriate AQMAs. In addition, NCC has supplied summaries of constant pressure data (WBAN33) (Ref: 11) for the upper air station at Greensboro, North Carolina. Mixing height information has been obtained from Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States, (Ref: 12). "Low-Level Inversion Frequency in the Contiguous United States," (Ref: 13) has been used to determine inversion frequencies for the AQMAs.

3.2.3 ADVECTION

Southwest is the predominate wind direction in Mecklenburg, Guilford and Forsyth Counties, but the predominate wind direction creating the greatest pollution potential is from the south because of slower wind speeds. Mecklenburg County normally has calmer winds than Guilford and Forsyth Counties, which suggests that a slightly greater air pollution potential exists for Mecklenburg County based on this factor alone.

3.2.4 ATMOSPHERIC STABILITY

The general climatological stability characteristics for the AQMAs are determined by using stability wind rose data supplied by the NCC. Stability is determined by applying the approach found in the Journal of Applied Meteorology (Ref: 14). Based on the assumption that Pasquill's stability categories E and F are conducive to higher pollution levels because they are more stable, it could be inferred that Guilford and Forsyth Counties may have a slightly less potential for the dispersion of pollutants when compared with Mecklenburg County. This would be true if other meteorological considerations are excluded. Stability characteristics, when considered in conjunction with advection characteristics (as discussed in Section 3.2.3) tend to suggest a similarity of general dispersion characteristics between the two areas. This might be expected because of the geographical proximity of the area.

3.2.5 TEMPERATURE INVERSIONS

Inversions restrict the atmosphere's ability to disperse pollutants. To supply an indication of the occurence of inversions in the AQMAs, the upper air station at Greensboro, North Carolina has been used and considered representative for all AQMAs. Reference 13 gives the frequency of the occurence of inversion conditions and the occurence of light nighttime surface winds. These data reflect a higher than normal frequency of inversions in the AQMAs as compared to the rest of the country. This is one reason why the southeastern section of the country is considered to have a higher pollution potential.

3.2.6 MIXING HEIGHTS

Mixing height, the height above the earth's surface to which pollution is likely to extend, has been considered. The average morning and afternoon mixing heights for Guilford and Forsyth Counties and Mecklenburg County are presented below. This information is obtained from Reference 12.

Guilford-Forsyth		Mecklenburg	
Morning	Afternoon	Morning	Afternoon
440 M	1450 M	400 M	1450 M

The mixing height for the year 1973 is much higher (i.e. 2235 meters) than these average values. This would mean better dispersion could have occurred during 1973 if everything else had been equal.

3.2.7 PRECIPITATION

Because rain, snow, and other forms of precipitation act as cleaning mechanisms for the atmosphere, and precipitation in both areas was higher than normal during the calibration year 1973, the air quality generally may have been better than normal during 1973 if all other factors remained constant. The average annual precipitation for Guilford and Forsyth Counties is 41.36 inches;

however, in 1973 46.78 inches of precipitation fell, and amounts greater than this have occurred only 6 times since 1934. For Mecklenburg County, the annual average precipitation is 42.72 inches. The total precipitation during 1973 amounted to 44.13 inches, and amounts greater than this have occurred only 16 times since 1934.

3.3 METEOROLOGICAL DATA USED FOR MODELING

3.3.1 GENERAL

The 1973 baseline year meteorological computer inputs have been refined with the expectation of obtaining a better calibration in each of the AQMAs. This refinement has consisted of using modified stability wind roses, mixing heights, temperature and pressure data. No refinements have been made to the meteorological data used for the projection years of 1975, 1980, and 1985.

3.3.2 REFINEMENTS TO 1973 METEOROLOGICAL DATA

3.3.2.1 INTRODUCTION

The following modifications have been made to the meteorological data for the calibration year 1973:

1. Stability wind rose data has been recalculated using only the days during which air sampling has been conducted.
2. Actual afternoon mixing heights have been calculated for each specific sampling period, and a revised annual average value has been determined.
3. Revised average temperature and pressure data have been calculated using the aforementioned sampling day approach.

These modifications have been made in order to better relate monitoring data to actual weather conditions during sampling. Using this approach, a higher degree of accuracy can be obtained in the modeling effort because the above modeling variables are used in lieu of the 365 day annual averages.

3.3.2.2 LUND WINDS

The new stability wind roses, referred to as "Lund Winds,"[2] have been determined by using the appropriate Local Climatological Data Summaries for each modeling area. Weather station summaries from Douglas Airport and Greensboro, High Point, Winston-Salem Regional Airport have been used for Mecklenburg County and Guilford and Forsyth Counties, respectively. Using these summaries in conjunction with the procedures outlined in Reference 14, new stability wind roses have been determined for only days on which sampling has been conducted. These modified stability wind roses using the above mentioned technique can also be obtained from NCC by special order.

3.3.2.3 MIXING HEIGHT REFINEMENTS

Mixing heights have been determined for both modeling areas by using radiosonde information in the form of constant pressure data supplied on WBAN33 forms. Since the only upper air station in the general area is located at Greensboro, the data from this upper air station has been used for all AQMAs. The afternoon mixing height for each sampling day has been determined by using afternoon soundings and applying the following criteria, listed in order of priority:

1. The height of low level (less than 500 mb.) elevated inversions if they existed.
2. The height of the first elevated strongly stable layer if no elevated inversions were found (less than 500 mb.).

[2]Modified stability wind roses developed by Steven C. Lund, Meteorologist, NCAQS, Raleigh, North Carolina, 1975.

3. The height of the 500 mb. pressure level if the soundings showed no strongly stable layers.

4. The height of the first recording pressure level if strongly stable conditions existed off the surface.

Using the above criteria, an overall average mixing height of 2235 meters has been determined for the days on which sampling has been conducted in 1973.

3.3.2.4 TEMPERATURE AND PRESSURE REFINEMENTS

Representative temperature and pressure values have also been determined by using only sampling day local climatological data. Although the difference between the average yearly data and average sampling day data is very small, the sampling day values are used for calibration. The difference is illustrated below.

TEMPERATURE AND PRESSURE

	Annual		Sampling Days	
	Temperature (°F)	Pressure (inches of mercury)	Temperature (°F)	Pressure (inches of mercury)
Mecklenburg Co.	59.80	29.25	59.05	29.24
Guilford & Forsyth Co.	57.60	29.13	57.16	29.12

3.3.3 SUMMARY OF METEOROLOGICAL INPUT DATA

For comparison purposes, both the 1973 and the projection meteorological parameters are listed below in Table XI.

TABLE XI

METEOROLOGICAL DATA USED IN THE AQDM

Calibration Year 1973

	Mecklenburg	Guilford and Forsyth
Stability:	Lund Winds	Lund Winds
Mixing Height:	2235 m	2235 m
Temperature:	288 °K	287°K
Pressure:	991 mb	986 mb

Projection Years 1975, 1980, and 1985

Stability:	NCC Stability Wind Roses (1969 to 1973)	NCC Stability Wind Roses (1968 to 1972)
Mixing Height:	1450 m	1450 m
Temperature:	289 °K	288°K
Pressure:	991 mb	986 mb

4. AIR QUALITY DATA AND MONITORING SITE ANALYSIS

4.1 INTRODUCTION

A description of the air quality data, the data validation procedures, and the monitoring site analysis techniques which are employed in the AQMA analysis are presented in this section. Specific examples are used where considered applicable to further clarify procedures. Summaries of the results of using the procedures and analysis techniques are supplied.

4.2 1973 AIR QUALITY DATA

4.2.1 GENERAL

The TSP data used to determine the AQMAs baseline air quality has been collected by the local air pollution control agencies in Mecklenburg, Forsyth, and Guilford Counties. These data have been submitted to the North Carolina Data Bank monthly and to the National Aerometric Data Bank quarterly. Sampling has been conducted for a 24-hour period once every six days. The TSP concentrations have been calculated in micrograms per cubic meter and recorded in the Storage and Retrival of Aerometric Data (SAROAD) format. At the end of the calendar year 1973, arithmetic means and geometric standard deviations have been computed for each monitoring site. The AQDM uses these statistics for calibration. The 1973 air quality data has been systematically validated.

4.2.2 DATA VALIDATION

4.2.2.1 PRELIMINARY DATA PREPARATION

In order to obtain a reliable calibration for each AQMA the air quality data has been closely scrutinized. This required site visitations

by NCAQS personnel to determine possible biasing of specific sampling day values by local sources of air pollution. These sources might include playgrounds, parking lots, or any unpaved area which cannot be adequately represented in the AQDM.

The decision has been made that it would be preferable, where possible, to exclude questionable readings during the calibration year rather than to totally reject a particular monitoring site. With this in mind, a method has been developed to analyze the individual 24-hour readings for the calibration year 1973. Since the sites have been visited by NCAQS personnel, all apparent biasing sources have been identified and taken into account.

The evaluation procedure consists of recording the entire year's monitoring data on a worksheet in the example format of Figure II. For the convenience of comparison, Guilford County and Forsyth County monitoring and meteorological data have been recorded on the same worksheet. The meteorological data consists of average advection conditions, predominate weather occurrences and prior weather conditions for each sampling day.

Several average values have been calculated from data contained on the worksheet. These values consist of an average reading for each day of the week at each monitoring site and the average air quality reading for the average daily wind direction. The air quality readings are grouped by the appropriate wind quadrant; Northeast (360° - 89°), Southeast (90° - 179°), Southwest (180° - 269°), and Northwest (270° - 359°). The average daily readings have been used to indicate which sampling days would require further investigation. Meteorological conditions have been examined in an effort to rationalize those concentrations exceeding the average. In most cases, the meteorological conditions having poor dispersion characteristics are congruent with the high readings.

FIGURE II

EXAMPLE WORKSHEET

1973

Weather Type	Wind Direction	Wind Speed (knots)	Observed TSP in $\mu g/m^3$ City Garage	Davie Rebane	Swing Road	South Main West Green	National Guard Armory	Date	Day	Weather* Past & Present
Fog Drizzle	SW	6.5	65	78	56	101	40	1/04/73	Thursday	A
4" snow on ground Clear	N	1.7	90	62	39	62	30	1/10/73	Wednesday	B
Clear	SSW	5.1	269	214	161	314	188	1/16/73	Tuesday	C
Rain Fog	S	6.4	116	86	32	102	42	1/22/73	Monday	D

*A - None of the conditions below were present

B - At least a half-inch of rain fell the day prior to monitoring

C - Dry conditions (four or more days without precipitation prior to monitoring)

D - Wet conditions (half an inch of rain fell during sampling)

4.2.2.2 VALIDATION TECHNIQUES

Three techniques for the validation of air quality monitoring data have been developed and utilized in a specific sequence. These are referred to as the "Area Analysis Approach," "Similar Day Approach," and the "Modeling Approach." They are used in conjunction with preliminary data preparation.

The first technique employed in the data validation sequence has been the area analysis approach. This approach involves the evaluation of other existing monitors in the general vicinity of the site under investigation in an attempt to corroborate a high reading. Further investigation is conducted only if a reading is disproportionately higher than those from surrounding monitors for that day.

If a reading is disproportionately higher, the second validation technique, the similar day approach, which compares air quality readings at the same site on days having similar meteorology, has been employed. In defining a similar day, the meteorological parameters found in Figure II and the day of the week on which sampling occurred have been considered. The similar day approach requires that a comparison considers all necessary parameters to determine the most similar day. It is not generally wise to compare weekday readings with weekend readings even though the meteorological conditions may be similar. By comparing readings from the questionable day and its similar day, large differences might suggest that further investigation is necessary.

If these approaches do not justify a high reading, a single source modeling approach is used to determine the impact of local sources near the site to see the impact of local sources on air quality at the monitoring site. The first two techniques are rather general because they are based on averages of what might be expected due to different meteorological conditions or a comparison of air quality readings within an area.

The third and final validation technique models nearby sources to determine if they might contribute substantially to a reading which appears excessively high. Modeling is possible because the general wind direction, wind speed, stability, and sources located upwind of the monitor are known. Modeling has been used for point sources because of the availability of necessary data, whereas area sources can only be handled through the use of the area analysis or similar day approaches. This modeling approach supplies an estimation of the impact of known sources of pollution on the monitoring site.

4.2.2.3 DATA VALIDATION EXAMPLE

An example of data validation for a specific monitoring site is presented to show how the monitoring site is evaluated and on what grounds particular readings have been rejected or accepted.

Example Monitoring Site Data Validation

City Garage (Greensboro)

The city garage is located in the southeastern section of Greensboro. The monitor is situated on the eastern edge of a large paved parking area. To the north of the monitor is a grassy, wooded area in a small ravine. No source of fugitive dust is apparent. East of the monitor is mainly grass and woods which are part of a golf course. The monitor is located atop a slight embankment consisting of weeds and brush. A paved parking area is located at the bottom of the embankment. A quarter mile east of the monitor is a truck depot which is largely unpaved, graveled, and not used extensively. Although this area can conceivably contribute fugitive dust to the monitor's reading under certain conditions, east winds are infrequent; therefore, the effects of this source of fugitive dust is minimized. During 1973, this impact is not apparent from the recorded values. In a southeasterly direction from the monitor, there are several buildings which appear to be minor contributing sources because of the general vehicular activity in the vicinity.

To the south is a source emitting about 17 tons of particulates per year from a stack and a large amount of dust from loading operations. This dust is believed to be a predominant factor in some high 24-hour readings. This source has been modeled to see if it might be the cause of some high readings. Results indicate that even though it is the largest point source in the area, its maximum contribution is substantially under recorded values. Also, in a southerly direction are a lumber yard, a hardware store, and building supply stores.

An analysis of sources located in the westerly direction from the monitoring site poses special problems which are not readily apparent unless the site is visited. Because this site is located next to a completely paved area, fugitive dust sources might not be suspected. However, due to a particular set of circumstances, the site seems to have the potential for fugitive dust influences as many road working vehicles are housed at the garage. These vehicles are very often caked with mud and dirt which falls to the pavement when they are moved about. This mud and dirt eventually wears down into fine dust particles by the grinding action of tires from vehicles located in the garage compound. Swirling dust has been observed at this site, which was probably caused by a combination of vehicle movement and winds. It is believed that these eddies of dust have influenced, and will continue to influence, this monitor. No other source of fugitive dust is apparent in this direction.

Table XII contains the average daily concentration values measured at this site for the year 1973. These averages are determined from, at most, nine readings during the year. Values should, therefore, be interpreted with this in mind. Table XIII contains the average concentrations by wind direction. Both of these tables are used in the data validation approach for determining the representativeness of individual daily air quality readings. Table XIV lists the monitoring days in 1973 examined in greater detail, decisions made as to their representativeness, and approaches used at arriving at such decisions.

TABLE XII

AVERAGE DAILY TSP CONCENTRATIONS FOR CITY GARAGE

($\mu g/m^3$)

Sunday	73	Thursday	110
Monday	129	Friday	119
Tuesday	147	Saturday	87
Wednesday	108		

TABLE XIII

AVERAGE TSP CONCENTRATIONS BY WIND QUADRANT FOR CITY GARAGE

($\mu g/m^3$)

Northeast	70	Southeast	76
Northwest	95	Southwest	109

TABLE XIV

RESULTS OF VALIDATION FOR CITY GARAGE

(1973)

Day of Week	Average For Day ($\mu g/m^3$)	Date	Actual Reading ($\mu g/m^3$)	Comments	Decision
Sunday	73	Apr. 22	115	AA	Accept
		June 3	88	AA	Accept
		Aug. 26	86	AA	Accept
		Oct. 7	123	AA, SDA (Apr. 22)	Accept
		Nov. 18	88	AA	Accept
Monday	129	Apr. 16	258	AA, SDA (Aug. 8)	Reject
		Nov. 12	189	AA, SDA	Accept
Tuesday	147	Jan. 16	269	AA	Accept
		May 22	335	M, AA, SDA	Reject
		Aug. 14	163	AA, SDA	Accept
Wednesday	108	May 16	201	AA, SDA	Reject
		Aug. 8	124	AA	Accept
		May 10	173	AA, SDA	Reject
Thursday	110	June 21	149	AA, SDA (Aug. 2)	Reject
		Oct. 25	140	AA	Accept
		Dec. 6	150	AA, SDA	Accept
Friday	119	Mar. 23	188	AA, SDA	Reject
		June 15	135	AA	Accept
		Oct. 19	163	AA	Accept
Saturday	87	Apr. 28	117	AA, SDA	Reject
		Sept. 1	107	AA	Accept
		Oct. 13	118	AA	Accept

AA - Area Analysis approach used
M - Modeling employed
SDA - Similar Day Analysis approach used

4.2.2.4 DATA VALIDATION SUMMARY

The original reading reported in SAROAD for each monitoring site, adjusted SAROAD values after the data validation, and the calculated AQDM values in Reference 2, are presented in Table XV.

Once the calculated values for the monitoring sites were determined from the modeling effort, the adjusted SAROAD values were compared with these calculated values. Such a comparison and comments are found in the third and fourth columns of Table XV. Except for the Walkertown site, the analysis has helped obtain a better relationship between observed and calculated values in the calibration procedure.

TABLE XV

CONCENTRATION COMPARISION

($\mu g/m^3$)

1973 Arithmetic Means

Guilford and Forsyth Counties

MONITORING SITE	SAROAD ACTUAL	SAROAD REVISED	CALCULATED (UNADJUSTED*)	COMMENTS
Clemmons	74	74		
Govt. Center	87	84	66	helped
Patterson Avenue (R.J. Rey.)	97	91	73	helped
Agri. Building	85	86	59	same
Hanes Hosiery Park	87	87	61	same
Rural Hall	49	49	30	same
South Fork	65	63	35	helped
City Garage	110	95	87	helped
Davie Mebane	100	100		
Swing Road	53	53	64	same
Main & Green	98	95		
Nat. Guard	67	65	63	helped
City Court	97	95		
Walkertown	43	39	48	hurt

Mecklenburg County

Fire Station #10	73	71	46	helped
Fire Station #11	66	66	42	same
Fire Station #14	54	51	30	helped
Com. Hospital	79	79	53	same
Filter Plant	49	49		
Pump Station	36	35		
Health Dept.	59	59	42	same
Water Plant	108	108		
Mint Hill	44	42	12	helped
N. 29 Pat.	58	58	21	same
McAlpine Creek Sewage Plt.	42	39	14	helped
Carp. Airport	32	32		

4.3 MONITORING SITE ANALYSIS

4.3.1 GENERAL

During the calibration period of running AQDM, the model has indicated sampling sites which appear to be either too high or too low in relation with calculated values of air quality. In order to determine if possible local biasing is taking place at these monitoring sites, a special study team was dispatched to these monitoring sites to do further investigation.

4.3.2 SITE INVESTIGATION PROCEDURE

The investigation procedure has involved the use of additional high volume samplers in the immediate vicinity of the permanent sampling sites to note any differences with respect to areas outside of the effects of local biasing sources. These studies have been conducted to validate or reject suspected biases and to partially substantiate possible monitoring site rejections. The studies have not been designed to evaluate exact causes of high readings, but only to supply information and insight to large local contributing factors. It is very important to point out that, although a monitor might be rejected because biasing local sources cannot be adequately represented by the AQDM, it should not be interpreted that the monitoring site is not representative for measuring air quality in that area. If local biases do exist, they would affect the local air quality. However, such a locally biased monitor should not be construed as being representative of general air quality over an extensive area. AQDM assumes a flat terrain and cannot take into account the effects of buildings and other topographical features which might influence actual measured values at particular monitoring sites.

An example of a monitoring site rejection analysis is given in Section 4.3.3.

4.3.3 EXAMPLE OF MONITORING SITE REJECTION

Site: Beatties Ford Water Plant

Location: Mecklenburg County

Reason For Rejection: This site is believed to be biased by an unpaved parking area and possible effects of chemical loading operations at the water plant, which cannot be properly represented by the AQDM in total AQMA dispersion modeling.

Basis For Rejection: Intensive monitoring in the immediate area of the monitor.

Method Employed: In addition to the permanent monitor (No. 1) at the site two other high volume samplers (No. 2 and No. 3) were deployed in the immediate vicinity of the water plant during a regular 24-hour sampling period.

Location of Monitors: Monitor No. 1 is located at a height of eight feet above the ground, 200 yards north of the water plant. Monitor No. 2 was located south of the water plant facility approximately 350 yards from monitor No. 1. Monitor No. 2 was placed at a height of three feet above the ground (height of instrument shelter). Monitor No. 3 was juxtaposed with monitor No. 1 at a height of three feet above the ground. After 24-hours of sampling by monitor No. 2 south of the water plant, this monitor was moved to the site of monitor No. 1 north of the plant, in order to check the accuracy of the sampling equipment.

Duration of Monitoring: During the regular 24-hour sampling period, both the north (No. 3) and south (No. 2) monitors were operated, collecting four six-hour samples, beginning at midnight. The permanent monitor (No. 1) was operated continuously for the 24-hour period.

To better define parking lot influences, a two-hour sample was collected for the period of ingress/egress, and a two-hour sample was collected when the lot was not in use. A five-hour sample was collected from the permanent monitor (No. 1) and an additional monitor (No. 2), both located at the height of eight feet. This was done simultaneously to measure the difference between the monitors' readings. The total study time lasted approximately thirty-six continuous hours.

Meteorological Conditions: During most of the thirty-six hours, winds were from the south to southwest. Wind speeds varied from calm during early morning hours to ten miles per hour for afternoon periods. The conditions were favorable for transport of fugitive dust from the parking lot and water plant operations to the monitors north of the water plant. Skies were generally clear with occasional scattered clouds.

Objectives of Investigation: The objective was to locate and determine effects of possible emissions coming from sources other than those already taken into account in the emissions inventory. Two such sources were identified and studied by using the procedures previously outlined. These sources are the lime and other chemical dumping operations which take place daily at the water plant, which may produce as much as 1.5 tons of particulate a year, and the employees' unpaved parking lot adjacent to the regular monitor. By studying the four six-hour sampling intervals, it is possible to relate concentrations to given activities. The midnight to 6:00 a.m. interval measured the effects of the dumping operations, the 6:00 a.m. to noon interval measured the effects of vehicle ingress, the noon to 6:00 p.m. interval measured the effects of vehicle egress, and the 6:00 p.m. to midnight interval measured the lack of effects from any of the suspected sources.

Results: From Table XVI, the most striking comparison was found from measuring the effects of the parking lot when in use and when not in use. Concentrations were twice as high when the lot was in use as indicated by the two-hour samples taken north of the plant. Vehicle ingress was occuring during the 6:44 a.m. to 8:45 a.m. sampling period. This is again made apparent by the egress of the cars at the end of the working day and is seen by the samples taken north and south of the plant for the time period of approximately noon to 6:00 p.m. on June 17, 1975. With winds from the south, this would be expected in that the

samplers which recorded the high concentrations were downwind of the parking lot. This large effect is not apparent during vehicle ingress on the 17th. As would be expected, no large difference was found for the sampling period of 6:00 p.m. to midnight for the sites north and south of the plant due to non-use of the parking lot during this time. The influence of dumping operations is also considered a factor, but due to constraints limiting the scope of the investigation, this influence could not be fully determined. Simultaneous operation of the regular monitor with an adjacent high volume sampler gave a difference of 20 $\mu g/m^3$. This might indicate the range of sampling error.

Conclusions: This monitoring site does appear to be influenced by the use of an unpaved parking area to such a degree that its usefulness in calibration is questioned. Therefore, data from this monitor was eliminated for calibration purposes.

TABLE XVI

BEATTIES FORD MONITORING DATA

MONITOR NO. & LOCATION*	DATE	SAMPLING INTERVAL	FLOW RATE	TIME (MIN.)	VOL (m^3)	WT (g)	$\mu g/m^3$
No. 3 NWP	6/18/75	8:50 A.M.-10:45 A.M.	1.911 m^3/min	115	218.2	0.0226	108
No. 3 NWP	6/18/75	6:44 A.M.- 8:45 A.M.	1.987 m^3/min	121	240.4	0.0512	213
No. 3 NWP	6/17/75	12:34 P.M.- 6:33 P.M.	1.678 m^3/min	359	602.3	0.1228	204
No. 2 SWP	6/17/75	12:27 P.M.- 6:25 P.M.	1.758 m^3/min	358	629.4	0.0473	75
No. 3 NWP	6/17/75	7:35 A.M.-12:31 P.M.	1.642 m^3/min	296	486.1	0.0230	47
No. 2 SWP	6/17/75	6:55 A.M.-12:24 P.M.	1.895 m^3/min	329	623.5	0.0621	100
No. 3 NWP	6/17-18/75	6:35 P.M.-12:45 A.M.	1.671 m^3/min	370	626.0	0.0735	117
No. 2 SWP	6/17-18/75	6:27 P.M.-12:30 A.M.	1.789 m^3/min	363	649.4	0.0601	93
No. 3 NWP	6/18/75	12:48 A.M.- 6:35 A.M.	1.756 m^3/min	347	609.2	0.0500	82
No. 1 NWP	6/17-18/75	7:45 A.M.- 7:47 A.M.	1.632 m^3/min	1442	2363.1	0.3481	149
No. 2 NWP	6/18/75	8:08 A.M.- 1:02 P.M.	1.692 m^3/min	294	497.4	0.0559	112

*NWP - North of Water Plant

*SWP - South of Water Plant

4.3.4 SUMMARY OF MONITORING SITES USED IN CALIBRATION

Table XVII supplies a listing by name of the final monitoring sites used in the calibration for each of the AQMAs. This list of monitoring sites is a result of the site investigation procedures.

TABLE XVII

MONITORING SITES USED IN CALIBRATION

Mecklenburg County

Map Key No.	SAROAD No.	
1	34-0700-010	Fire Station #10
2	34-0700-003	Fire Station #11
3	34-0700-004	Fire Station #14
4	34-0700-002	Charlotte Community Hospital
5	34-0700-011	County Health Department
6	34-2580-001	Mint Hill
7	34-0700-008	North 29 Patrol Station
8	34-0700-014	McAlpine Creek Sewage Plant

Guilford-Forsyth Counties

1	34-4460-008	Government Center
2	34-4460-002	Agricultural Building
3	34-4460-009	Hanes Hosiery Park
4	34-4460-003	Patterson Avenue (R. J. Reynolds)
5	34-1480-002	Rural Hall
6	34-4460-005	South Fork
7	34-1480-001	Walkertown
8	34-1740-002	City Garage
9	34-1780-010	Swing Road
10	34-2000-003	National Guard Armory

Figures III and IV locate each of these sites in the AQMAs. As can be noted, Guilford County has a less extensive sampling network than Forsyth and Mecklenburg Counties. Some of the monitors located near county borders have not been used in calibration because of the lack of a total emission inventories for the surrounding counties, i.e. influences from upwind sources in neighboring counties cannot be modeled and would therefore bias the calibration process.

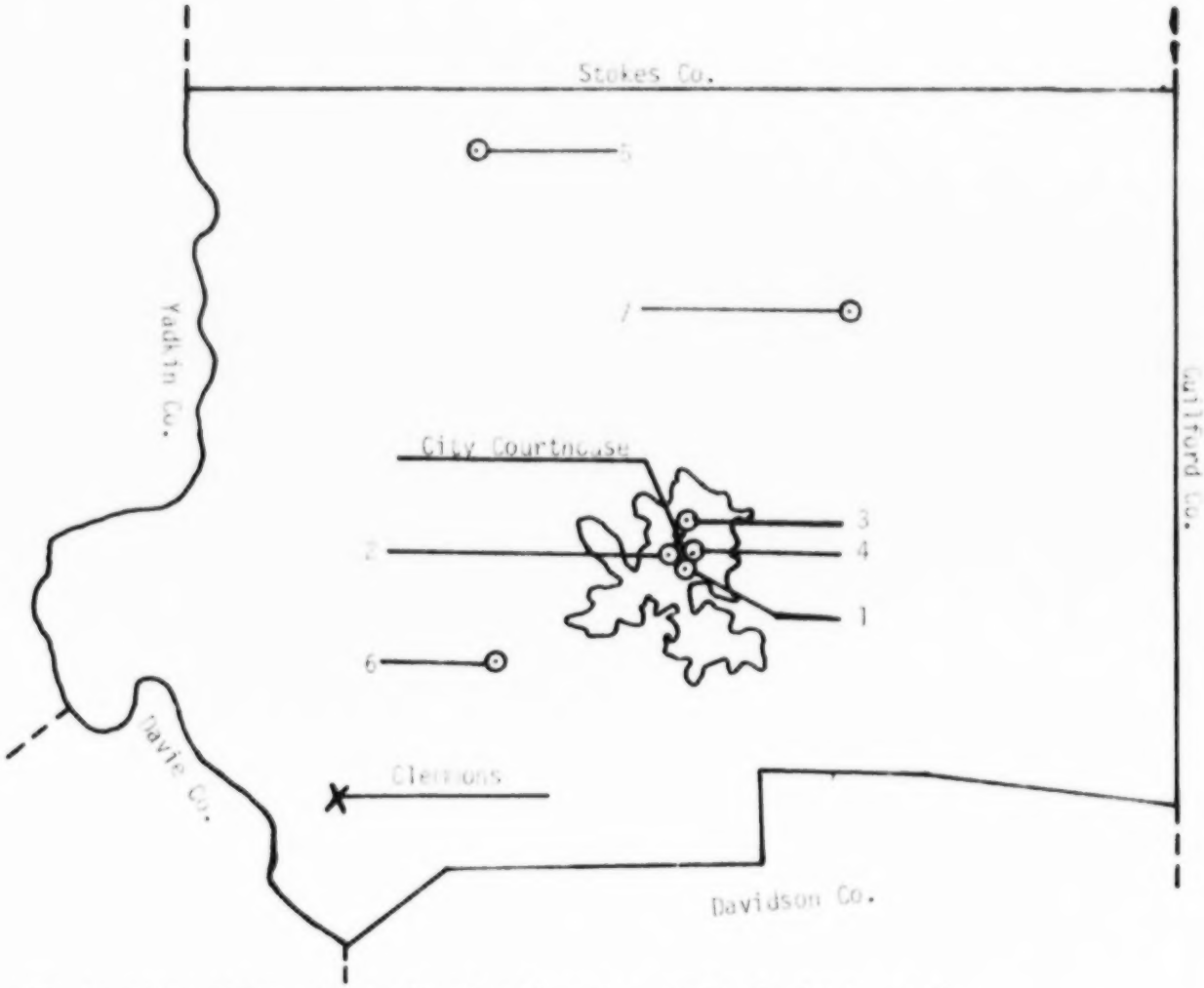
FIGURE III

MECKLENBURG COUNTY AIR MONITORING NETWORK*

⊙- Sampling sites used in final calibration (Refer to Table XVII).
X- Sampling sites rejected for final calibration
* - Monitors initially considered appropriate for modeling.

FIGURE 1.

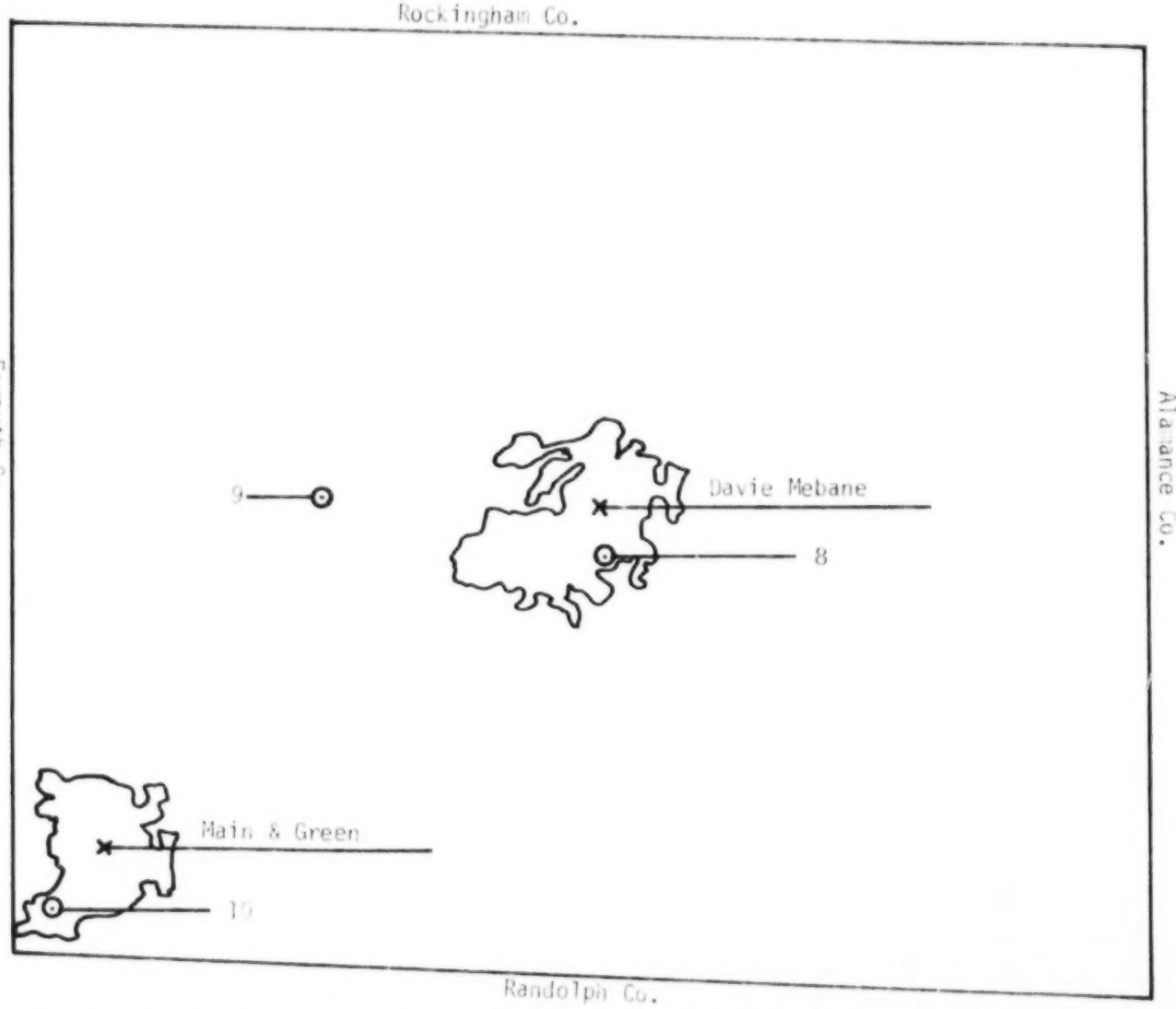
FORSYTH COUNTY AIR MONITORING NETWORK*



⊙- Sampling sites used in final calibration (refer to Table ...).
✗- Sampling sites rejected for final calibration.
* - Monitors initially considered appropriate for modeling.

FIGURE V

GUILFORD COUNTY AIR MONITORING NETWORK*



⊙- Sampling sites used in final calibration (refer to Table XVII).
✕- Sampling sites rejected for final calibration.
* - Monitors initially considered appropriate for modeling.

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